

ANALYSIS OF CO₂ EMISSION REDUCTION AND ENERGY INTERACTIONS IN TURKEY VIA GENETIC ALGORITHM AND BUEMS-MACRO FOR ELECTRIC VEHICLES

Cem Tiranlar, Bogazici University, Phone +90 536 295 17 27, E-mail: cemtiranlar@gmail.com
B. Cem Avci, Bogazici University, Phone +90 212 359 64 10, E-mail: avci@boun.edu.tr
Gurkan Kumbaroglu, Bogazici University, Phone +90 212 359 70 79, E-mail: gurkank@boun.edu.tr

Overview

Estimating energy demand becomes a vital issue in today's world. Especially after industrial revolution, the energy demand has increased exponentially; however, energy has not been distributed adequately due to lack of energy sources. Therefore, estimation of energy demand is necessary to find sustainable solutions.

In addition to this, the energy demand facilitates to calculate GHG emissions as well. Except for the renewable energy, all of the energy production and consumption processes cause GHG emission which has a destructive impact on the environment. With the growing demand, GHG emission tends to increase inherently.

Because of these circumstances, numerous methods are developed to forecast the future energy demand. These methods can be an algorithmic solution or bottom-up energy models. These two different perspectives enable us to reach the consistent values. In this way, GHG emissions might be calculated correctly as well.

This study is organized as follows: Electric vehicles will be more important in the near future. Therefore, their impacts in Turkey are evaluated within the scope of this study. Firstly, the energy demand in transportation is computed in two different applications; such as algorithmic and bottom-up energy models. Then, the utilization behavior of electric vehicles is taken into consideration via data from Turkish Statistical Institute and other institutions so that future energy demand can be estimated. Finally, new scenarios for energy supply are developed according to Turkey's future plans. Thus, impacts of electric vehicles on the environment can be determined.

Methods

Genetic algorithm application on MATLAB: Genetic algorithm is an adaptive heuristic search method based on evolutionary ideas of genetics and natural selection. This algorithm was firstly developed by John Holland and their friends in University of Michigan. His works, *Adaptation in natural and artificial systems*, were published in 1975. Still the interest in Genetic Algorithm rises nowadays. Genetic Algorithm is useful for solving problems as well as modelling, and its area of usage extends day by day.

Boğaziçi University Energy Modeling System (BUEMS): The Boğaziçi University Energy Modeling System (BUEMS) is a bottom-up modeling framework that includes a partial equilibrium representation of the energy system, describing it in great detail and trying to find the least-cost combination of energy technologies to meet energy demand that restricted by technological availability, the potential of energy sources and emissions.

Results

Firstly, energy demand in transportation sector is calculated with the help of the genetic algorithm. Genetic algorithm enables us to reach energy demand equation of Turkey with respect to some parameters such as GNP, population. And then, BUEMS is used for the demand estimation as a bottom-up model.

After the estimating energy demand, CO₂ emissions in Turkey is evaluated. For a long time it has the tendency to increase although it has fluctuated in some years. However, this trend will be changed because of the electric vehicles. The main reason is that these vehicles won't consume fuel oils compared to old ones.

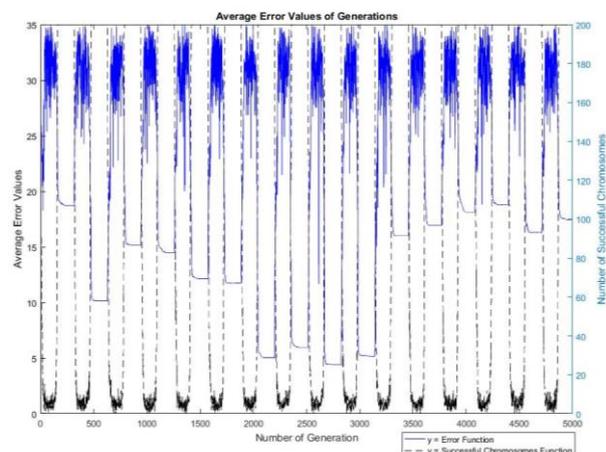


Figure 1. Application of Genetic Algorithm

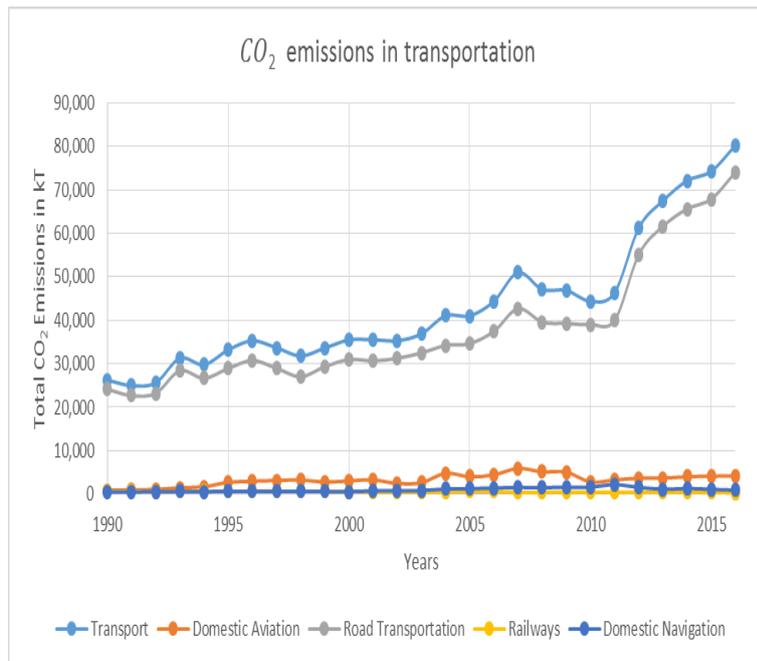


Figure 2. CO₂ emissins in transportation in Turkey

Finally, new energy sources due to additional energy demand from the electric vehicles are compared to each other. Renewable sources have undoubtedly better impact on the environment rather than other sources such as thermal plants. Nevertheless, the effect of refineries shouldn't be ignored while calculating CO₂ emissions. In addition to GHG emission savings from fuel oil consumption, refineries will emit less as well thanks to decrease in fuel oil production.

Conclusions

All of the models show that energy demand will increase in the future as usual. In Turkey, increasing population and economic developments are the main reasons for this increase. Then, possible energy sources are evaluated in order to forecast GHG emission changes due to the electric vehicles. Therefore, an optimum solution can be derived.

Due to Paris Agreement and other environmental movements, all of the countries have to be careful for their future energy sources plan. They have to find some sustainable ways to many economic activities such as carbon taxes. Therefore, it can be said that electric vehicles might add another dimension in the economy, especially developing countries.

References

Or, Gurkan Kumbaroglu Ilhan, and Mine Isik. "Analysis of the Turkish Energy Sector with the BUEMS Energy Modelling Framework." *Meeting the Energy Demands of Emerging Economies, 40th IAEE International Conference, June 18-21, 2017*. International Association for Energy Economics, 2017.

Haldenbilen, S., H. Ceylan, 2005, "Genetic algorithm approach to estimate transport energy demand in Turkey", *Energy Policy*, Vol. 33, pp. 89-98.

Sonmez, M., A.P. Akgüngör, S. Bektaş, 2017, "Estimating transportation energy demand in Turkey using the artificial bee colony algorithm", *Energy*, Vol. 122, pp. 301-310.

Hickman, R., D. Banister, 2007, "Looking over the horizon: Transport and reduced CO₂ emissions in the UK by 2030", *Transport Policy*, Vol. 14, pp. 377-387.

Cai, Hao, et al. "Well-to-wheels greenhouse gas emissions of Canadian oil sands products: Implications for US petroleum fuels." *Environmental science & technology* 49.13 (2015): 8219-8227.